ABSTRACT

TITLE: Use of climate variation to forecast mosquito abundance and encephalitis risk in California.

INVESTIGATORS:

Research team composition		
Name	Affiliation	Role on Project
William K Reisen	Center for Vecotrborne Diseases, UCD	PI, Medical Entomologist
Bruce F. Eldridge	Center for Vectorborne Diseases, UCD	Databases, Web-sites
Chris M. Barker	Center for Vectorborne Diseases, UCD	PhD Student, GIS and RS analysis
Vicki Kramer	Vector-borne Disease Section, DHS	Section Head, Risk Assessment
Kenneth Linthicum	Vector-borne Disease Section, DHS	Climate and surveillance data analysis
Steve Mulligan	Mosquito & Vector Control Assoc Calif	Integration of results into operations
Chris Voight*	Mosquito & Vector Control Assoc Calif	Executive Director, communications
Daniel Cayan	Scripps Institution of Oceanography, USGS	Climate analysis
Mary Tyree	Scripps Institution of Oceanography, USGS	Programmer analyst
Mike Dettinger	Scripps Institution of Oceanography, USGS	Hydrology and climate analysis
Henry Diaz*	Climate Diagnostic & Prediction Center, NOAA	Climate forecasting
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Introduction: In this extension of an ongoing 3 year award funded by the Joint Program on Climate Variability and Human Health, we propose to extend our on-going research and applications development by spatially and temporally expanding climate analyses, incorporating remote sensing data, and enhancing data management, analysis and decision support tools. Our multidisciplinary team of medical entomologists, climate diagnosticians and control practitioners has been expanded to include remote sensing scientists at the California Department of Health Services [DHS] and NASA. Leveraging pending funding from NASA, our overall goal focuses on integrating climate variability and forecasting information into public health policy and decision making by the California Encephalitis Virus Surveillance Program [CEVSP] coordinated by DHS and applied by member agencies of the Mosquito and Vector Control Association of California [MVCAC]. New analyses will improve our understanding of how climate variation affects the cascade of ecological events that alter the risk of human and equine infection with endemic encephalitides, western equine encephalomyelitis [WEE] and St. Louis encephalitis [SLE]. Our primary goal remains to improve the use of climate forecasting at varying scales to warn health officials of changing risks of encephalitis virus activity by extending our understanding of the retrospective relationships among climate variability and arbovirus epidemiology. These will provide important background information and decision support systems to address the pending invasion of California by **West Nile Virus [WN].**

Enzootic amplification of WEE and SLE within the summer bird-mosquito cycle is managed by 53 vector control district that protect >26,346,000 California residents [or 1 in 12 US citizens] inhabiting >57,000 square miles. Human vaccines and therapeutic drugs currently are not available for these viruses, and vector abatement remains the only method of preventing human infection. Effective vector abatement relies strongly upon accurate surveillance information to provide sufficient warning to implement timely intervention. The CEVSP was established formally in 1970 under the direction of the Vector-borne Disease section and the Viral and Rickettsial Disease Laboratory of DHS and currently monitors mosquito abundance and encephalitis virus infection rates, virus transmission to sentinel chickens, and human and equine cases from Shasta to the Mexican border. The long-standing collaboration among MVCAC agencies, DHS and the University of California entomologists and arbovirologists is unparalleled and has resulted in the unique accrual of long-term surveillance information. The extensive, regularly sampled, ongoing collection of mosquito abundance and enzootic virus activity data provides a unique opportunity to understand the spatial and temporal dynamics of WEE and SLE amplification over a large region. Diagnostics recently were expanded to detect the introduction of WN and documented 1 locally transmitted and 7 introduced human and 1 introduced equine WN cases during 2002.

Rationale: Amplification of encephalitis viruses to levels that place the human population at eminent risk of infection depends principally on the dynamics of virus replication in the mosquito host related to temperature and mosquito population size related to surface water availability. The availability of global and especially tropical Pacific Ocean/atmospheric observations and dynamical and statistical models now permit the long range forecasting of climatic conditions at several seasons in advance, whereas short-range (one month to two seasons) forecasts, hydrological models and in situ observations in the California region provide accurate depictions of snow pack, run-off and soil moisture. Spatial and temporal changes in wetness and vegetation can be sensed remotely and used to monitor ecological change over large areas. We propose to define quantitative relationships among climate, mosquito abundance and enzootic virus amplification retrospectively to forecast the level of virus risk during the current and/or following transmission seasons. Long-range forecasts will be used of fiscal planning by vector control districts to anticipate above average water availability and therefore mosquito abundance and encephalitis risk, whereas short-range forecasts will be incorporated into decision support systems to estimate risk and used to scale immediate operational responses for public protection. We propose to extend current methods of sharing surveillance data that will permit local vector abatement personnel to use these forecasts and models to make rapid and accurate analyses and predictions of disease risk to make decisions on intervention.

Work completed: During the previous granting period, we visited all 53 mosquito control agencies in California and gathered mosquito abundance and virus surveillance records that were in various electronic and paper formats. To date, 2.5M trap nights of mosquito abundance data have been entered into standardized electronic format and stored in a centralized database at UC Davis. An immediate on deliverable to collaborating agencies has been uniquely geocoding all trap locations in California and

providing these historical records to collaborating agencies has been uniquely geocoding all trap locations in California and providing these historical records to collaborating agencies in electronic format for their internal use. Surveillance information is combined into a risk assessment model, and we have used our historical data in conditional simulations to verify the utility of these algorithms. Preliminary analyses of mosquito data have progressed concurrently and showed that abundance patterns vary spatially among the different biomes of California, but have strong links to climate variation. Examining these links using the final data set is the focus of our proposed new research.

Work proposed: Proposed new research will extend on-going investigations on how climate variability impacts the temporal and spatial dynamics of mosquito populations and the pathogens they transmit. Using information collected by the CEVSP as a model system, retrospective relationships among climate variability, mosquito abundance and the activity of WEE and SLE viruses will be delineated to prospectively forecast the risk of virus transmission that may impact the health of California residents. New research will define spatially assemblages of climate and epidemiological data that covary temporally, exploit these relationships prospectively to forecast mosquito and arborvirus activity, and develop Internet-based tools to use this information in a decision support system for mosquito control and health agencies in California.

Specifically our goals may be summarized as follows:

1. Use spatial statistics on normalized indices on mosquito and virus activity to align areas of California into ecological assemblages that covary concurrently and therefore may be driven by similar signals.

2. Quantify relationships among mosquito abundance, enzootic virus transmission and human infection using historical and recent surveillance information to ascertain thresholds and predictive probabilities for human infection. Adjust these relationships to accommodate the invasion of California by WN.

3. Quantify long- and short-range predictive relationships among global and regional climate variability, hydrology of key watersheds and other mosquito habitat, remotely sensed vegetative indices and soil moisture, and indices of adult mosquito abundance and virus activity.

4. Assess the utility of hydroclimatic forecasts to predict mosquito abundance and virus transmission risk seasons-in-advance to assist in planning intervention by mosquito control and health agencies.

5. Develop a Web-based electronic decision support system for the input, archiving, exchange, visualization and analysis of data collected by the CEVSP.